

Advanced Accelerator Applications (AAA) Program

Background

In FY 1999, Congress directed the Department of Energy to develop a “Roadmap” to determine the feasibility and life-cycle cost of an Accelerator Transmutation of Waste Technology (ATW) system to manage the civilian nuclear spent fuel from U.S. reactors. The results of this study are published in a report to Congress, “A Roadmap for Developing Accelerator Transmutation of Waste Technology,” October 1999, (DOE/RW-0519). The report addressed issues associated with the question of whether the ATW concept could benefit the waste management system associated with disposing spent fuel from all existing U.S. nuclear plants during their anticipated lifetimes. If successful, the ATW concept transforms plutonium, long-lived actinides, and long-lived fission products contained in spent fuel by changing atomic structures. After transmutation, the new less radioactive isotopes can be stored in a safe place such as Yucca Mountain. By transmutation of material in spent fuel, the potential exists to : 1) significantly reduce the quantity of fissionable material stored in a repository, 2) produce further power from material in spent fuel, and 3) as a result of associated fission product partitioning, permit repository heat management with the potential to significantly enhance the capacity for waste storage in the existing repository - possibly eliminating the need for additional repositories in the foreseeable future.

Independent of the ATW exercise, the U.S. Department of Energy is also responsible for insuring adequate future tritium production needs of the nation. Although a reactor based option has been chosen as the primary vehicle to meet the needs, an Accelerator Production of Tritium (APT) backup option exists which to date has developed impressive technology which appears of direct value to demonstrating the ATW objective of benefitting nuclear waste management.

Recognizing the potential synergistic value of ATW and APT, as well as the possibility of supporting the nation’s nuclear energy-related education and research infrastructure with an integrated accelerator applications facility, the DOE Office of Nuclear Energy, Science and Technology under Congressional

guidance established as a new AAA Program Office and initiated in FY 2001 an Advanced Accelerator Applications (AAA) program whose primary objective will be to conduct scientific and engineering research, development and demonstration to ascertain if cost effective and beneficial transmutation of civilian spent nuclear fuel is possible.

New Nuclear Energy Advanced Accelerator Applications Program

Under the AAA program, the limited lab-scale research planned for the ATW program, as described in the, “Roadmap for Developing Accelerator Transmutation of Waste Technology” would be modified to include greater emphasis on industrial scale-experimental research, and proof by experiment. This approach has the potential to significantly reduce the time to demonstrate “waste transmutation,” and may reduce the total prototype demonstration cost. It is envisioned that such an approach could have an experimental facility operational in less than 10 years.

Program Goals – three primary goals of AAA program:

- Demonstrate the capability to produce tritium, as a backup resource, should the Department require tritium in the longer term future (2010 and beyond).
- Develop and demonstrate, within an approximately ten-year period, an environmentally sound and cost-effective technology that could be used to convert U.S. inventories of civilian spent nuclear fuel (63,000 metric tonnes) to a waste form which: 1) has a significant reduction in the radiological toxicity (at least two-orders-of magnitude reduction) and fissile material, 2) is of significantly less volume (at least a factor of 2), and 3) is in a form acceptable for disposition in the proposed Yucca Mountain repository.
- Explore the science and technology of accelerator driven systems (coupled accelerator/target/subcritical nuclear fuel assemblies), and the application of these systems to important national technology goals.

Program Objectives

The objectives for the AAA program are to conduct scientific and engineering research and development, to demonstrate cost effective transmutation of civilian spent nuclear fuel, and support maintaining the nation's capability to produce tritium. This will be accomplished by integrating and upgrading of the existing Low Energy Demonstration Accelerator (LEDA) from 6.7MeV to 500MeV with a spallation target (which produces approximately 7.5 neutrons per collision), and coupling this with modular subcritical nuclear fuel assemblies in different experimental configurations and environments.

An integrated/coupled systems has never been demonstrated before, and hence, a significant amount of scientific and engineering research will be required. This approach will provide the foundation for a completely new area of nuclear engineering research and technology. AAA research will also contribute to the re-invigoration of nuclear science and engineering and help train a new generation of nuclear energy experts. Last, this program will contribute, and support U.S. leadership in advanced nuclear technology through the establishment of a new, first-of-a-kind, world-class research facility.

Research Topic Areas

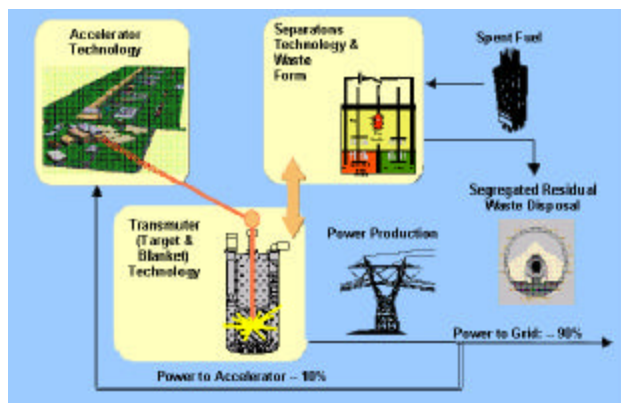
The AAA program integrates the science of spallation-neutron physics with nuclear reactor physics, thermal-hydraulics, heat transfer, and materials into one coupled system which is generally referred to as Accelerator Driven System. Research proposed within the AAA program includes:

- Advanced Fuels: High Zirconium/Actinide Fuels Research and Development.
- Spent Fuel Separations Research and Development (oxide and metal).
- Subcritical Nuclear Fuel Assembly Design and Thermal-Hydraulics.
- Coolant Compatibility and Heat Transfer (Gas, Sodium, and Lead/Lead-Bismuth).
- Environmentally Acceptable, and Cost-Effective Fuel Processing (Conversion of LWR spent fuel in oxide form to metal fuel for transmutation).

- Spallation Target Design, Cooling, and the Science of Coupling Spallation Neutrons with Nuclear Fuel Assemblies.
- Research and Development of new material which can withstand high energy, high neutron flux levels, high temperatures, and be compatible with the reference fuel and coolant.
- High Energy Accelerator Reliability.

FY 2001 Planned Accomplishments:

- Initiate preconceptual design of the Accelerator Driven Test Facility (ADT-F).
- Provide a report to Congress by March 1, 2001, outlining the complete AAA program with costs, schedule and deliverables.
- Initiate NEPA related activities.
- Pursue obtaining international collaboration to support the AAA program and have at least one major partner by the end of 2001.
- Establish university grants program.



| Program Budget AAA (\$ in Millions) | | | |
|---|---------|--------------------------|--------------------------|
| | FY 1999 | FY 2000 Appropriation | FY 2001 Appropriation |
| ATW | \$0.0 | \$8.4 | \$0.0 |
| AAA | \$0.0 | \$0.0 | \$34.0* |

* Excludes additional \$34.0M for Accelerator Production of Tritium provided under Defense Programs that will be part of the AAA program.

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